



Research Article

## Design, Development and Evaluation of Herbal Gel for Treatment of Psoriasis

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### Abstract

The aim of present study was to prepare herbal gel formulation containing methanolic extract of *Ricinus Communis* on psoriasis. Topical gel formulation was designed by using methanolic extract of seeds of *Ricinus Communis* in varied concentrations. The gel was prepared by using carbopol 940(1%w/v), Ricinus Communis Extract, ethanol, propylene glycol, methyl paraben, propyl paraben, EDTA disodium, tri-ethanolamine and required amount of distilled water. The prepared gels were evaluated for physical appearance, pH, spread ability, drug content, swelling index, diffusion study, viscosity, homogeneity and grittiness. It was inferred from results that gel formulations were good in appearance and homogeneity.

**Key words:** *Ricinus Communis*, carbopol 940, herbal gel, psoriasis

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### 1. Introduction

Psoriasis is a common T-cell-mediated immune disorder characterized by circumscribed, red, thickened plaques with an overlying silver-white scale. Psoriasis is regarded as an autoimmune disease in which genetic and environmental factors have a significant role. The name of the disease is derived from Greek word 'psora' which means itch. Psoriasis is a non-contagious, dry, inflammatory and ugly skin disorder, which can involve entire system of person. It is mostly inherited and mainly characterized by sharply margined scaly,

erythematous plaques that develop in a relatively symmetrical distribution. The most commonly affected sites are the scalp, tips of fingers and toes, palms, soles, umbilicus, gluteus, under the breasts and genitals, elbows, knees, shins and sacrum[1].

Gel as semisolid, being either suspensions of small inorganic particles or large organic molecules interpenetrated with liquid. A gel is a semisolid system of at least two interpenetrating phases: a gelling agent and a liquid. Gels that contain water are called hydrogels, while those

that contain an organic liquid are called organogels. Hydrogels, in the broad sense, include the matrix of water - soluble materials such as cellulose derivatives and natural gums[2].

## 2. Materials and methods

*Ricinus communis* Extract obtained from chakrapani Ayurveda research center Jaipur rajasthan. Carbopol 940(1%w/v), Ricinus Communis Extract, ethanol, propylene glycol, methyl paraben, propyl paraben, EDTA disodium, tri-ethanolamine were obtained from Research fine lab, Mumbai.

## 3. Characterisation of *Ricinus Communis* Physiochemical Analysis

In order to identify various physiochemical parameter studied including description, solubility, Accelerated solvent extraction (ASE 50), pH, loss on drying and heavy metals.

### Description

*Ricinus Communis* extract was evaluated for physical appearance by visual observation.

### Solubility

Sufficient excess amount of *Ricinus Communis* extract was added to amber coloured glass vials containing 10 ml of distilled water. The vials were sonicated for 1 to 2 hours at room temperature. The solutions were allowed to equilibrate for next 24 hours and then centrifuged for 5 minutes. The supernatants of each vial were filtered through Whatman filter paper, diluted suitably with distilled water and analyzed spectrophotometrically at 281 nm

### Accelerated solvent extraction (ASE 50)

The *Ricinus Communis* seeds were ground using a commercial coffee grinder and then further crushed with a mortar and pestle (the particle diameter should be less than 3 mm when finished). Place a cellulose filter at the outlet end of the extraction

cell. Weighed out 3 to 10 g of sample in a beaker and mix with Dionex ASE Prep DE if the sample is wet (1:1 w/w). If not, mix with Ottawa sand (approximately 1:1 w/w) and loaded into the extraction cell. Fill any void volume with clean Ottawa sand. Weigh and label the appropriate number of collection vials and place in the Dionex ASE 50 system vial carousel. Place the loaded cells in the cell carousel. Set up the method described in the Extraction Conditions and begin the extraction. When the extractions are complete, remove the collection vials and place into Dionex ASE Pucks. Load the Dionex ASE Pucks into the Rocket Evaporator and run the appropriate preprogrammed evaporation method. When using petroleum ether, use Evaporation Method 1 for very low boiling point solvents. Note that samples can be removed from the Dionex ASE 50 system and added directly to the Rocket Evaporator. The Rocket Evaporator will evaporate the solvent to dryness and will stop automatically when all solvent is evaporated[3]. Extraction conditions were shown in table 1.

Extraction conditions		
Sr.No.	Solvent	Petroleum ether 100%
1	Oven Temperature	105 °C
2	Static Time	10 min
3	Static Cycles	3
4	Flush Volume	100 %
5	Purge time	6 sec

Table 1: Extraction conditions

### pH

A 1 % w/v solution of *Ricinus communis* extract in distilled water was prepared, filtered and the pH read on a pH meter[4].

### Loss on Drying (LOD)

1.5 gm of powder of weighed into thin porcelain dish. Powder was dried in oven at 100°C. It was cooled in desiccator and

loss in weight was recorded as moisture[5].

#### **Total Ash Value**

2gm of powdered extract was weighed into the dish. Dish supported on a pipe clay triangle placed on a ring of Tripod stand. Heated with a burner, using a flame about 2cm high and supporting dish about 7 cm above the flame, powder was heated till vapours almost ceased to be evolved; then lowered the dish and heated more strongly until all the carbon was burnt off. The powder was cooled in desiccator. Weighed the ash and calculated the percentage of total ash with reference to the air dried sample of the crude drug[5].

Wt. of the empty dish= X

Wt. of drug taken= Y

Wt. of the dish + ash (after complete incineration) = Z

Wt. of ash= (Z-X) g

'Y' g of the crude drug gives (Z-X) g of ash

Therefore 100 g of the crude drug gives  $100/Y \times (Z-X)$  g of ash

Total ash value of sample=  $100 (Z-X)/Y$  %

#### **Heavy Metals**

Anodic and adsorption stripping voltammetry were applied for the determination of trace amounts of metals in examined samples of herbs. Basic electrolyte and solutions of samples were introduced to the polarographic vessel. Before each measurement the sample solution was bubbled with nitrogen for about 10 min. and then blank was recorded. Concentration of analytes in samples was found by three-five times standard addition method. After each addition of standard to a polarographic vessel, the solution was deoxidised for 30 sec. To the solutions obtained in the mineralisation process acetate buffer of pH 4.7 was added. For the determination of Zn, Cd and Pb electrolytic concentration at the potential  $E = -1.10$  V was carried out on a hanging mercury electrode against Ag/AgCl electrode during 40 s. Analysis of

nickel was carried out in 0.1 M ammonium buffer medium of pH = 9.3, containing 1% dimethyl-glyoxime (30  $\mu$ l) in ethanol and potassium peroxydisulphate (VI). Enrichment was continued for 140 s. In the case of molybdenum 0.2 M hydroxyquinoline (20  $\mu$ l) and SnCl<sub>2</sub> (II) as a reducing agent (10  $\mu$ l) were applied. Measurements were recorded at a speed of potential change 20 mV/s, impulse height 50 mV, impulse width 100 ms, sensitivity 0.1 nA. For calibration and validation of analytical procedure CRM oriental tobacco was applied. Solutions of CRM used in the standard addition method were obtained by successive dilution of stock solution[6].

#### **Microbiological Analysis**

In order to check microbial contamination of *Ricinus Communis* extract various microbiological tests performed including total plate count, total yeast and mould, *Escherichia Coli*, *Salmonella* spp., *Staphylococcus aureus*.

#### **Pretreatment of Sample**

Dissolved 10 gm of *Ricinus Communis* extract in buffered sodium chloride peptone pH 7.0 under condition of test and adjusted volume to 100 ml.[7]

#### **Total plate count**

1ml of sample was prepared and poured into sterile petri dish with 15 ml of soyabean digest agar. Petri dish was swirled to obtain good distribution. Plates were incubated at 30 to 35° for 3 days. Number of colonies formed was counted at the end of 3<sup>rd</sup> day[7].

#### ***Escherichia Coli***

10 gms of *Ricinus communis* extract in was diluted to 100 ml using casein soyabean digest broth as diluent and incubated at 30 to 35° for 18 to 24 hr. After incubation broth was shaken and transferred 1 ml to 100 ml MacConkeybroth. Incubated at 42 to 44° for 24 to 48 hr. Subcultures were prepared on plate of MacConkey agar and incubated at 30 to 35° for 18 to 72 hr. Growth of pink, non-mucoid colonies

indicates the possible presence of *E.coli*. This should be confirmed by identification test. If there is no growth of such type of colonies or the identification tests are negative it indicates absence of *E.coli* and product passed test[7].

### **Salmonella**

Prepared sample of *Ricinus communis* Extract and inoculated in casein soyabean digest broth incubated at 30 to 35° for 18 to 24 hr.

After incubation shaken broth and transferred 0.1 ml to 10 ml Rappaport Vassiliadis Salmonella enrichment broth and incubate at 30-35° for 24 to 48 hr. Subcultured were prepared on a plate of Wilson and Blair's BBs agar and incubated at 30 to 35° for 24 to 48 hr. Green colonies with black center develop and in 48 hr colonies become uniformly black. Colonies surrounded by dark zone and metallic sheen indicates possibility of presence of salmonella. If subcultured on plates of xylose lysine deoxycholate agar and incubate at 30° for 24 to 48 hrs. If well-developed red colonies with or without black centers are produced it indicates possibility of salmonella. This should be confirmed by identification tests. If there is no growth of such type of colonies or identification tests are negative indicates absence of salmonella and product passes test[7].

### **Staphylococcus aureus**

Casein soybean digest broth was used as diluent. Inoculated 10 gm of *Ricinus communis* extract in 100 ml casein soyabean digest broth incubate at 30 to 35° for 18-24 hrs. Subcultured on plate of mannitol salt agar incubate at 30-35° c for 18-72 hrs. Yellow or white colonies with yellow zone indicate the possibility of presence of *S.aureus*. This should be confirmed by identification test. If there is no growth of such type of colonies or the identification tests are negative it indicates

absence of *S.aureus* and product passes test[7].

### **Phytochemical Analysis**

The extract were tested for the presence of active chemical compounds by following methods

#### **Test for Tannins**

1ml of the extract was added with 5ml of distilled water and kept for boiling in hot water bath. After boiling sample was cooled down and to this 0.1% ferric chloride solution was added. Appearance of brownish green or black coloration confirms the presence of tannins[8].

#### **Test for Phlobatannins**

1% of HCl was added to the extract (1ml) and boiled in hot water bath at about 90 to 100°C. Formation of red precipitate indicates the presence of phlobatannins [8].

#### **Test for Saponins**

1ml of the extract was taken in a test tube and distilled water (2ml) was added to it. The test tube was then kept in boiling water bath for boiling and was shaken vigorously. Existence of froth formation persisted for next one hour confirms the presence of saponins[8].

#### **Test for Terpenoids**

5ml of extract was taken in a test tube and 2ml of chloroform was added to it followed by the addition of 3ml of conc. Sulphuric acid. Appearance of yellow colour and its disappearance on standing indicates the positive tests for flavonoids [8].

#### **Tapped density**

The appropriate quantity of drug was sifted through #60 sieve and transfer in graduated cylinder. Then the cylinder was mechanically tapped containing the sample by raising the cylinder and allowing it to drop under its own weight using mechanically tapped density tester that provides a fixed drop of  $14 \pm 2$  mm at a nominal rate of 300 drops per minute. The cylinder was tapped for 500 times

initially and measure the tapped volume (V1) to the nearest graduated units, repeat the tapping an additional 750 times and measure the tapped volume (V2) to the nearest graduated units.<sup>9</sup> If the difference between the two volumes is less than 2 % then final the volume (V2) is calculated by following formula

$$TAPPED\ DENSITY = \frac{\text{weight of powder}}{\text{tapped volume}}$$

### Hausner's ratio

Hausner's ratio gives an idea regarding the flow of the blend. It is the ratio of tapped density to the apparent density. Hausner's ratio was calculated and values were compared with the corresponding Hausner's ratio given[9].

$$HAUSNER'S\ RATIO = \frac{\text{Tapped density}}{\text{Bulk density}}$$

### Compressibility Index

The compressibility index measures of the propensity of powder to be compressed. The packing ability of drug was evaluated from change in volume, which is due to rearrangement of packing occurring during tapping. It is indicated as Carr's compressibility index (CI) and can be calculated as given in the formula given and the compressibility index which was calculated was compared with the corresponding compressibility index[9].

$$COMPRESSIBILITY\ INDEX = \frac{\text{Tapped density} - \text{Bulk density}}{\text{Bulk density}}$$

### Angle of repose

Flow properties depend on particle size, shape, porosity and density of bulk powder. The flow characteristics are measured by angle of repose. The relationship between angle of repose and powder flow is given. Improper flow of powder is due to frictional forces between

the particles. These frictional forces are quantified by angle of repose. Angle of repose is defined as the maximum angle that can be obtained between the freestanding surface of a powder heap and the horizontal plane.

$$\theta = \tan^{-1}(h/r)$$

Where, h = height of pile.

r = radius of the base of pile.

$\theta$  = angle of repose

Method: A funnel was held with a clamp such that the stem of the funnel is 2 cm above the graph paper that is placed on a horizontal surface. Weighed amount of powder (5g) was taken and poured in to the funnel keeping the orifice of funnel blocked. The powder was allowed to flow by removing the blockage. Height (h) and average of six diameters formed by the pile of the powder was measured by ruler and the angle of repose was determined [9].

### FT-IR Spectroscopy

Shimadzu FTIR spectrometer Prestige 21 was used in Attenuated total reflectance (ATR) mode for collecting FT-IR spectra of samples. The spectra's were collected over the range of 4000-400cm<sup>-1</sup> in 45scans, with resolution of 5cm<sup>-1</sup> for each sample.

### Differential Scanning Calorimetry (DSC)

Thermal analysis was performed by differential scanning calorimetry of the formulation using a differential scanning calorimeter DSC-60A Shimadzu calorimeter. These ample amounts of powder (about 7-10mg) were placed in aluminum pans, sealed hermetically and then these hermetically sealed aluminium pans were heated at a scanning rate of 20°C/min from 50°to160°C under constant purging dry nitrogen flow (20mL/min). Empty aluminium pan was used as a reference.

### 3. Formulation of Gel

The gel was prepared using dried methanolic Extract of Ricinus Communis.



The gel was prepared using carpool 940 (1%), propylene glycol, Ethanol, Methyl paraben, Propyl paraben, EDTA Disodium, Triethanolamine and Distilled water in quantity to prepare 100 gm gel. Water required for the formulations was divided into two parts. In one parts the exact amount of extract was dissolved and to this calculated quantity of ethanol and propylene glycol was added and in other part, carbopol 940 was dissolved and to this solution methyl paraben, propyl paraben, and EDTA Disodium was added. Both of this solutions were mixed in beaker and triethanolamine was added mixture dropwise to obtain gel consistency[10-14]. Master formula for F1 to F9 gel formulation was shown in table 2.

#### 4. Evaluation Of Gel

##### pH

The pH values of 1% aqueous solutions of the prepared *Ricinus Communis* gel were measured by a pH meter (Lab Electronics Ltd.)[15]

##### Viscosity

The viscosity of the gel formulations was determined using Brookfield viscometer with spindle no. 4 at 10 rpm[15].

##### Spreadability

The spreadability of the gel formulations was determined at 24 h after permeation, by measuring the spreading diameter of 1 g of gel between two horizontal plates (20 cm × 20 cm) after one min[16,17].

##### Drug content

About 1 gm of gel was accurately weighed and transferred to 100ml volumetric flask to which about 70ml distilled water was added. After mixing the volume was made up to 100ml distilled water. The content was filtered through a suitable filter paper. An aliquot of 1ml was pipetted out from filtrate. The extract was estimated spectrophotometrically by using shimadzu UV/VIS spectrophotometer-1700 at 281 nm[18].

#### *In vitro* diffusion study

The diffusion studies of the prepared gels were carried out in franz diffusion cell for studying the dissolution release of gels through a cellophane membrane. Gel sample (1gm) was taken in cellophane membrane and the diffusion studies carried out at  $37 \pm 1^\circ \text{C}$  using distilled water as dissolution medium. Five millilitres of each sample was withdrawn periodically at 1,2,3,4,5,6,7,8,9,10,11,12 and 24 h and each sample was replaced with equal volume of dissolution medium. The samples were analysed for the drug content by using distilled water as blank[18-20].

#### Extrudability study

After the gels were set in the container, formulations were filled in the collapsible tubes. The extrudability of formulation was determined in terms of weight in grams required to extrude a 0.5 cm ribbon of gel in 10 seconds[21].

#### Swelling index

To determine the swelling index of prepared topical gel, 1 gm of gel was taken on petri dish and then placed separately in a 50 ml beaker containing 10 ml distilled water. Then samples were removed from beakers at different time intervals and put it on dry place for some time after it reweighed[22]. Swelling index was calculated as follows

$$\text{Swelling Index (SW) \%} = [(W_t - W_o) / W_o] \times 100.$$

Where, (SW) % = Equilibrium percent swelling,

$W_t$  = Weight of swollen gel after time  $t$ ,

$W_o$  = Original weight of gel at zero time.

#### Homogeneity

After the gels have been set in container, all developed gels were tested for homogeneity by visual inspection. They were tested for their appearance and presence of any aggregates

**Grittiness**

All the formulations were evaluated microscopically for the presence of any appreciable particulate matter which was seen under light microscope. Hence obviously the gel preparation fulfils the requirement of freedom from particular matter and form grittiness as desired for any topical preparation[2].

**Stability studies**

stability testing for 3 months as per ICH norms at temperature of  $30^{\circ} \pm 2^{\circ}\text{C}$  /  $65\% \pm 5\%$  RH and  $40^{\circ} \pm 2^{\circ}\text{C}$  /  $75\% \pm 5\%$  RH for intermediate and accelerated stability. The formulations were analysed for change in colour, appearance, spreadability, pH, and drug content[23].

**5. Result and Discussion**

The herbal gel was prepared and subjected to evaluation of various parameters. The gel was brownish in colour with a translucent appearance. The pH was constant throughout the study to about 6.8 and the gel did not produce any irritation upon application to the skin. Extrudability was excellent while spreadability was less variant after performing stability studies from that of the initially prepared gel. The initial viscosities were recorded at  $25^{\circ}\text{C}$ . Furthermore, the stability study's results revealed the preparation was stable under normal storage conditions.

Physiochemical analysis of *Ricinus communis* including description, solubility, ASE 50, pH, Ash content, loss on drying, Heavy metals were performed and results were reported in Table 3. Physiochemical analysis test results for *Ricinus communis* extract were within given specification. Hence, it complies with standards. Microbiological analysis of *Ricinus communis* including total plate count, total yeast and mould, *E.Coli*, *Salomonella spp.*, *S.aureus* were performed. The absence of *E.coli*, *Salmonella spp.* And *S. aureus* indicates that *Ricinus communis* extract

complies microbiological test requirements of I.P. Hence, it was suitable for use in topical gel formulation. Results of microbiological analysis were reported in Table 4. Phytochemical analysis of *Ricinus communis* including test for phlobatannins, saponins, terpenoids, tannins were performed and results were reported in Table 5. Phytochemical analysis showed presence of phlobatanins, saponins, terpenoids, and tannins in *Ricinus communis* Extract. Hence, sample extract complies with standard phytochemical tests.

Preformulation parameters of *Ricinus communis* was reported in Table 6. It was abseved from preformulation parameter that *Ricinus communis* extract is fair to passable in flowing properties.

Infrared spectra of sample of *Ricinus communis* extract depicted in figure 1 and major peak were as reported in table 7. It can be concluded that presence of C-H stretching, O-H stretching, C-O-O-H stretching peak resembles presence of Ricinoleic acid in Extract. Ricinoleic acid is principle phyto-constituent of *Ricinus communis*.

The Thermal Decompostion point of *Ricinus communis* was determined by the by Digital Melting Point apparatus. Thermal Decomposition point of *Ricinus communis* was found to  $251^{\circ}\text{C}$ .

The results of DSC study were reported in figure 2 to 4. Figure 2 shows endothermic peak at  $251^{\circ}\text{C}$  which confirms with determination of decomposition temperature by melting point apparatus. Figure 3 shows exothermic peak at  $117^{\circ}\text{C}$  which may be attributed to conversion of carbopol 940 solid to liquid sate. In figure 4 both peak not appear which indicate ability of carbopol 940 to form complex which might be useful in gel formation and prolonged topical action of *Ricinus communis*.

Formulation code	Carbopol-940 (gm)	Extract (gm)	Propylene glycol (ml)	Ethanol (ml)	Methyl paraben (gm)	Propyl paraben (gm)	EDTA (gm)	Distilled water Upto (gm)	Triethanol amine (ml)
F1	4	9	4	3	0.2	0.02	0.03	100	q.s
F2	1	9	2.5	3	0.2	0.02	0.03	100	q.s
F3	2.5	9	1	3	0.2	0.02	0.03	100	q.s
F4	4	9	2.5	3	0.2	0.02	0.03	100	q.s
F5	2.5	9	2.5	3	0.2	0.02	0.03	100	q.s
F6	2.5	9	4	3	0.2	0.02	0.03	100	q.s
F7	4	9	1	3	0.2	0.02	0.03	100	q.s
F8	1	9	4	3	0.2	0.02	0.03	100	q.s
F9	1	9	1	3	0.2	0.02	0.03	100	q.s

Table 2: Master formula of F1 to F9 gel formulations

Sr. No.	Specific test	Observed result	Specification
1	Description	Brown coloured dry powder	Brown coloured dry powder
2	Solubility(water)	92.25%	NLT 50%
3	ASE 50	89.29%	NLT 50%
4	pH 1%w/v solution	5.30	3-7
5	Ash content	3.8%	NMT 10%
6	Loss on drying	1.48	NMT 7%
7	Heavy metals	Complies	NMT 20 ppm

Table 3: Physiochemical analysis of *Ricinus communis*

Sr.No	Specific test	Observation	Result
1	Test for phlobatannins	Red ppt	Phlobatanins present
2	Test for saponins	Froth persisted for more than hour	Saponins present
3	Test for terpenoids	Reddish brown layer at junction of two solution	Terpenoids present
4	Test for tannins	Blue black colour	Tannins present

Table 5: Phytochemical analysis of *Ricinus communis*

Sr.No.	Specific test	Observed result	Specification
1	Total plate count	650Cfu/gm	NMT 1000Cfu/gm
2	Total yeast and mould	40Cfu/gm	NMT 1000Cfu/gm
3	E.Coli	Absent	Absent
4	Salmonella spp.	Absent	Absent
5	S. aureus	Absent	Absent

Table 4: Microbiological analysis of *Ricinus communis*

Sr.No.	Preformulation property	Observed value	Flow property
1	Bulk Density	0.68 gm/cm <sup>3</sup>	-
2	Tapped Density	0.83 gm/cm <sup>3</sup>	-
3	Carr's Index	18.07 %	Fair to passable
4	Hausner's Ratio	1.22	Fair to passable
5	Angle of Repose	31.79°	Fair to passable

Table 6: Preformulation parameters of *Ricinus communis*



Wave number( $\text{cm}^{-1}$ )	Inference
2422.15	--C-H stretching
3567.65	--O-H stretching
1018.23	HO-CO-- stretching
1700	--C=O stretching

Table 7: Principle Peaks and Frequencies of *Ricinus communis*

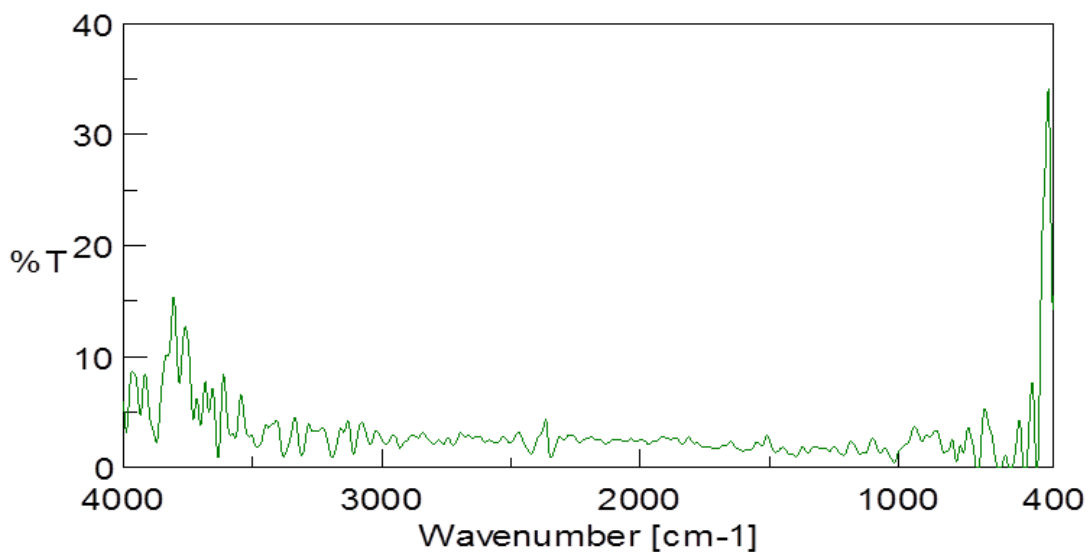


Figure 1: IR spectra of *Ricinus communis*

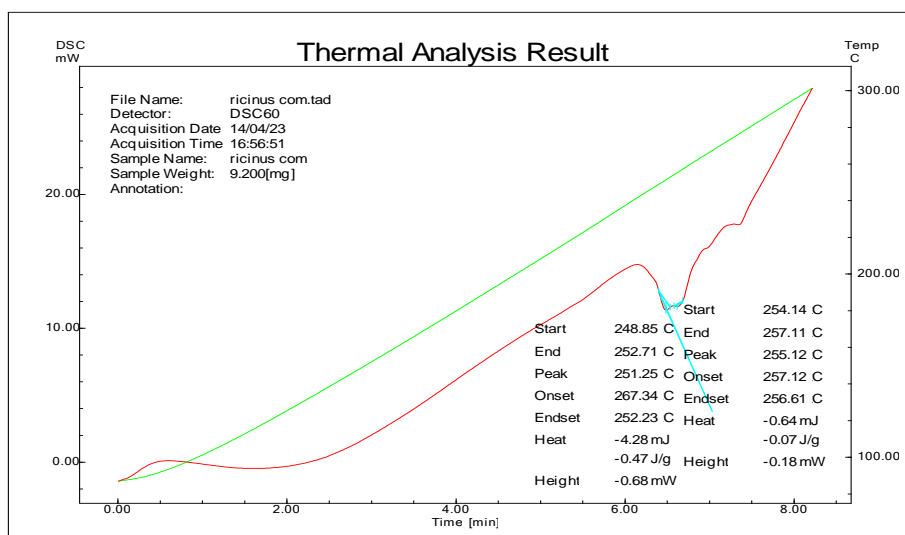


Figure 2: DSC of *Ricinus communis*

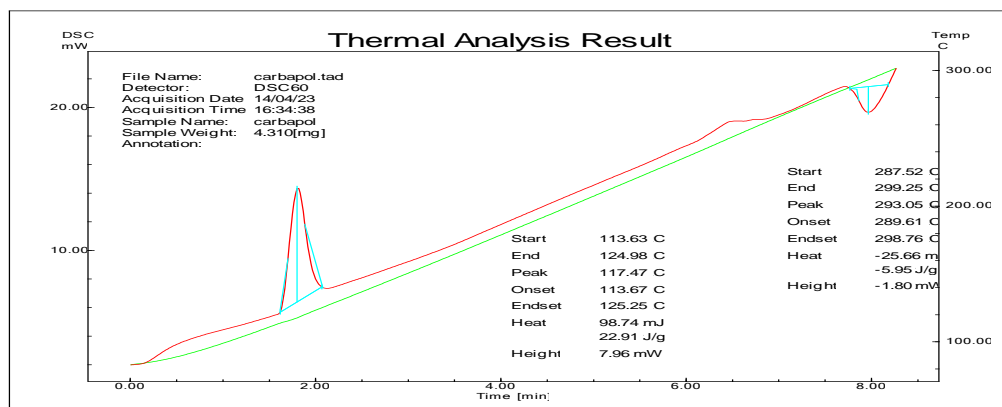


Figure 3: DSC of carbapol 940

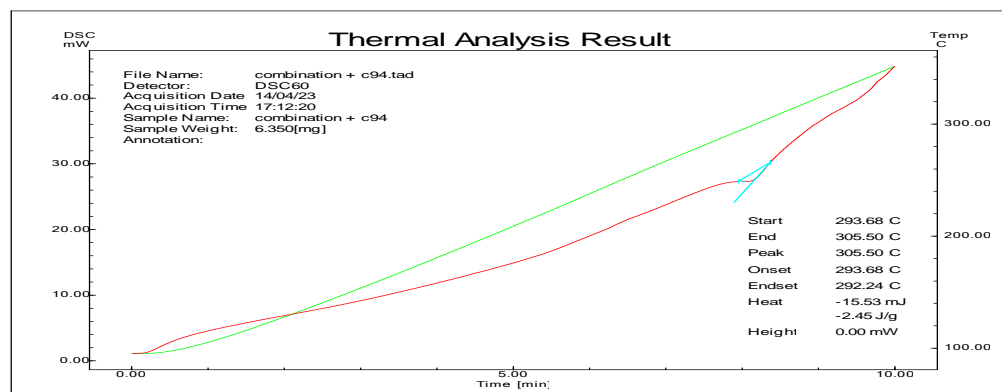
Figure 4: DSC of *Ricinus communis* and Carbapol 940

Figure 5: Spreadability of F1 to F3 gel formulations

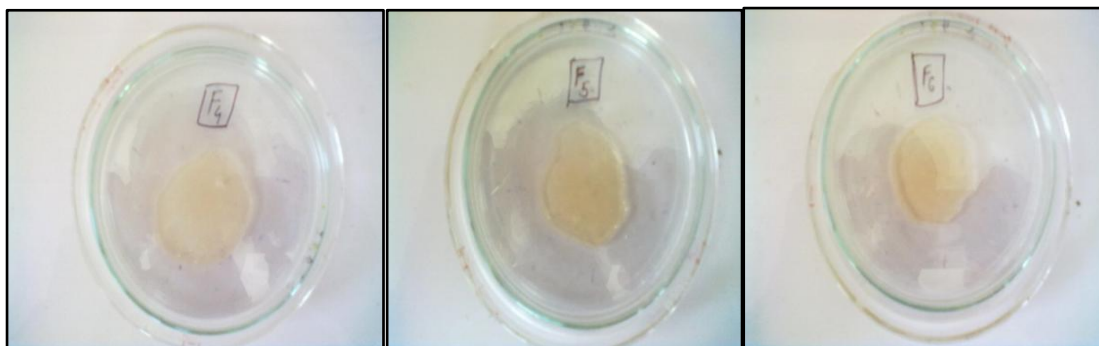


Figure 6: Spreadability of F4 to F6 gel formulations

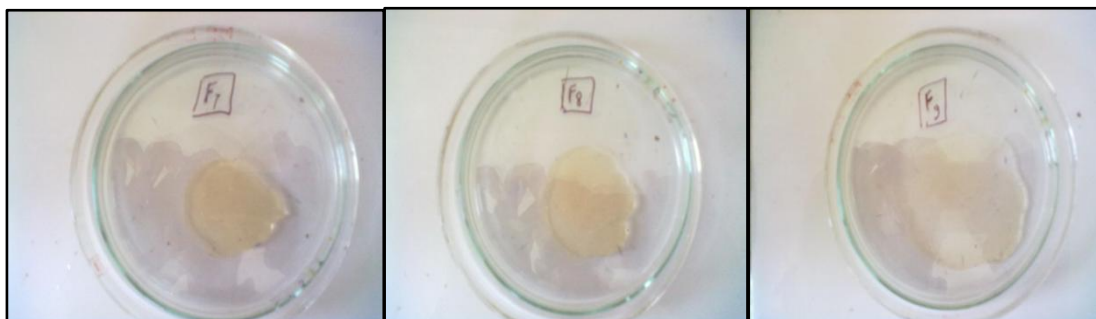


Figure 7: Spreadability of F7 to F9 gel formulations

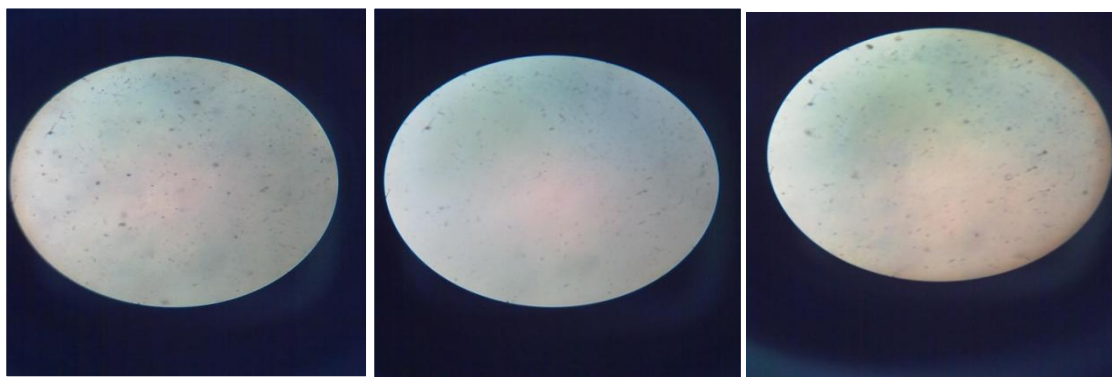


Figure 8: Microscopy of F1 to F3 gel formulations

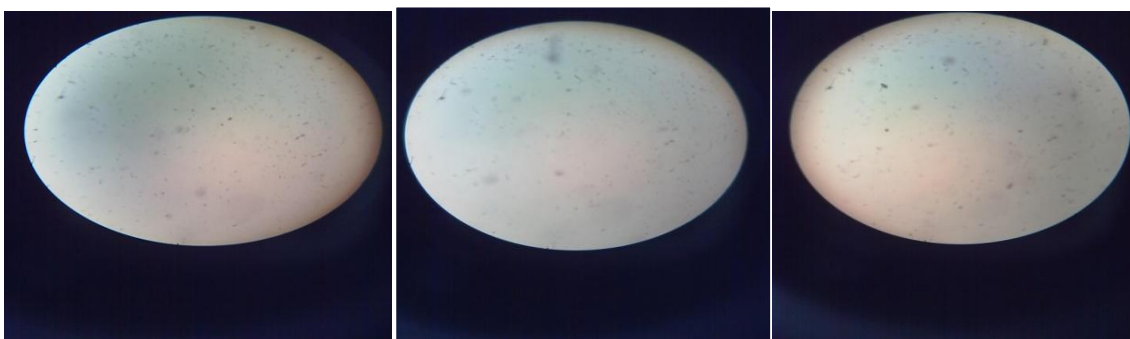


Figure 9: Microscopy of F4 to F6 gel formulations

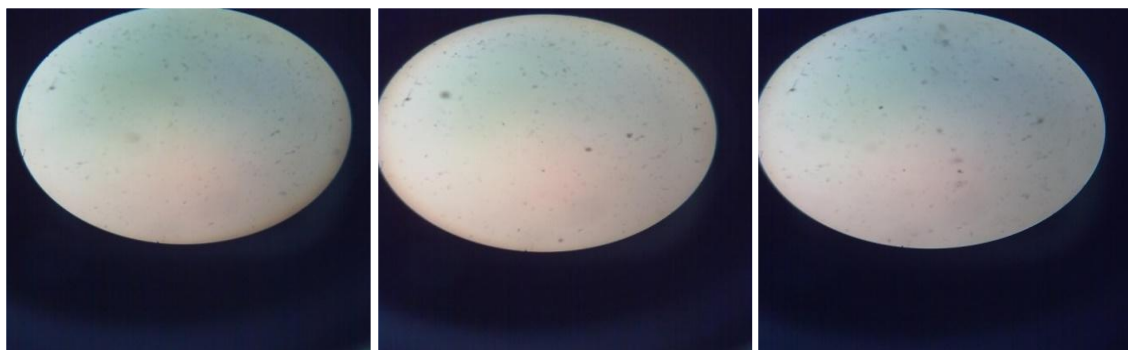


Figure 10: Microscopy of F7 to F9 gel formulations

	% Drug Release								
Time(Mins)	F1	F2	F3	F4	F5	F6	F7	F8	F9
15	5.83	9.07	4.88	7.77	4.77	6.88	4.88	6.22	4.88
30	7.14	11.17	11.44	10.33	8.55	7.55	5.11	8.55	13.55
60	9.93	13.74	15.77	10.77	12.77	14.44	5.55	11.11	17.24
120	45.55	26.22	24.44	28.66	16.11	25.77	8.55	13.33	31.71
180	49.45	40.03	39.11	51.55	43.44	39.66	11.33	27.88	48.18
240	51.78	53.26	51.55	55.33	53.88	47.66	28.66	35.88	60.02
300	57.48	56.22	61.66	60.22	57.44	58.33	50	51.77	65.08
360	65.51	66.77	64.22	64.66	59.11	60	57.44	57.68	68.67
420	68.67	70.11	66.77	65.66	66.88	69.44	60.77	66.66	71.64
480	70.11	71.22	70.77	69.66	68.88	72.22	67.77	68.22	74.38
540	78.33	88.88	86.11	75	85.33	81.11	77.88	79.77	74.83
1440	87.33	91.66	91.22	86.77	87	84.88	85.77	88.11	96.11

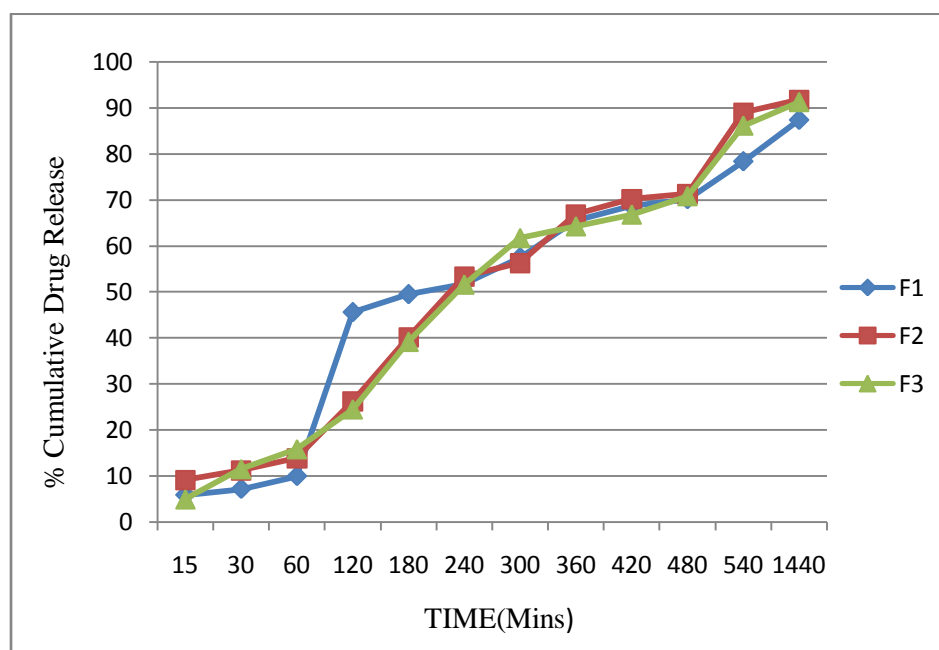
Table 8: *In vitro* drug release of F1 to F9 gel formulations

Figure 11: % cumulative drug release of F1 to F3 gel formulations

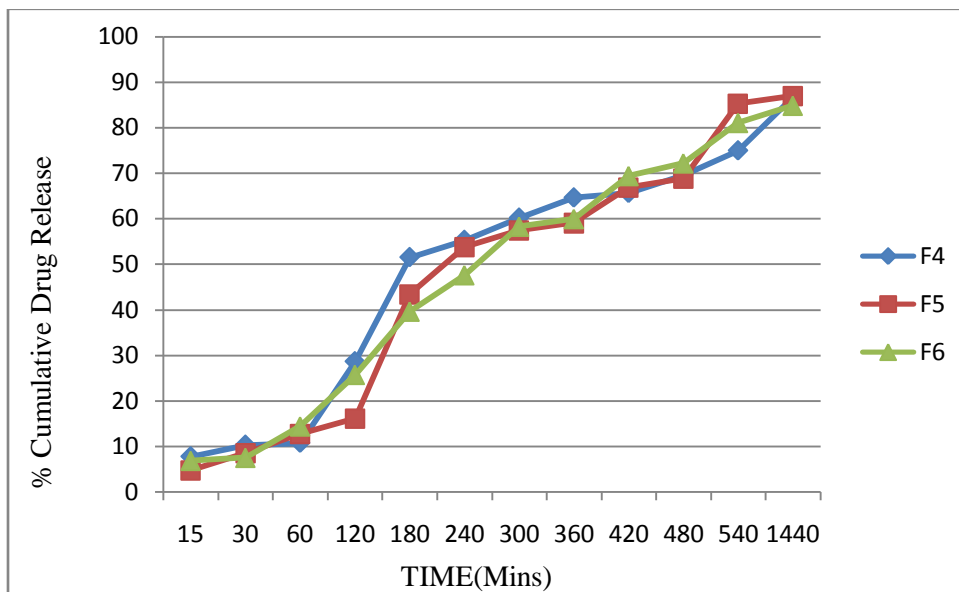


Figure 12: % cumulative drug release of F4 to F6 gel formulations

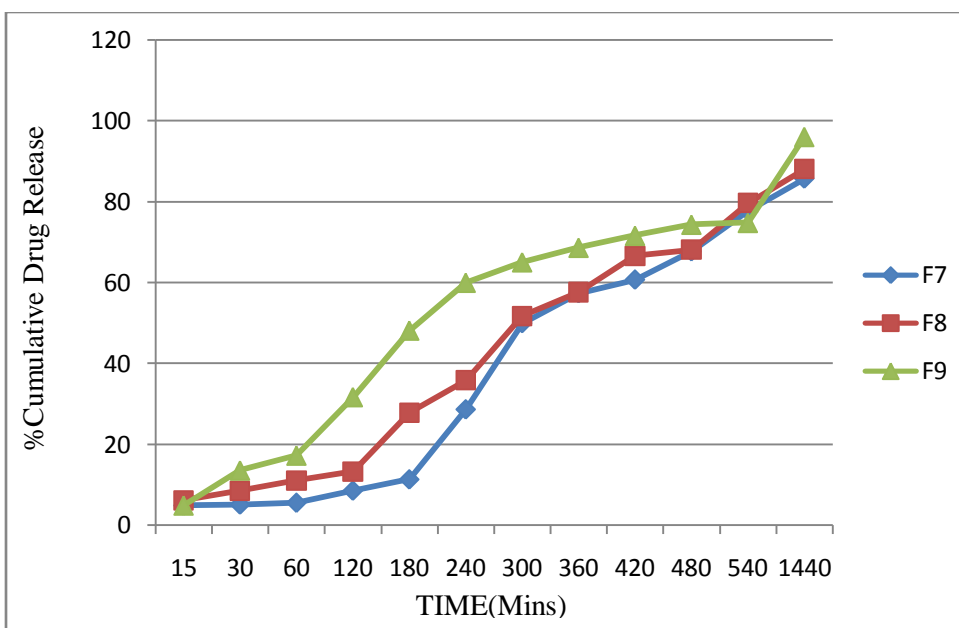


Figure 13: % cumulative drug release of F7 to F9 gel formulations



Formulation code	pH	Extrudability (gm/cm <sup>2</sup> )	Spreadability (mm)	Viscosity (cps)	Homogenicity	Grittiness	Swelling index (%)	Drug content (%)	Diffusion study (%)
F1	4.06	750	36.66	1308	Homogenous	NO	67	89.77	87.33
F2	5.12	1000	54.33	1210	Homogenous	NO	48	94.44	91.66
F3	4.83	800	36.33	1276	Aggregation	YES	76	92.88	91.22
F4	4.52	600	37.66	1368	Aggregation	YES	116	91.22	86.77
F5	4.84	820	36.66	1400	Homogenous	NO	105	91.66	87
F6	4.82	1100	30.66	1504	Homogenous	NO	95	90.44	84.88
F7	4.32	1250	32.33	1428	Homogenous	NO	142	88.44	85.77
F8	4.47	600	36.66	1511	Homogenous	NO	121	92.88	88.11
F9	5.62	600	53	1248	Homogenous	NO	91	97.33	96.11
Marketed(Rextop gel)	6.59	568	55	1425	Homogenous	NO	88.87	45	95.14

Table 9: Comparision of F1 to F9 gel formulations with marketed formulations

The pH of the gel formulations was in the range of 4.06 to 5.62 which lies in the normal pH range of the skin and would not produce any skin irritation. The pH values of F1 to F9 gel formulations shown in Table 9.

The viscosity of the gel formulations generally reflects its consistency. Decrease in viscosity of gel formulations showed increase in drug release. Viscosity of F1 to F9 gel formulations were shown in Table 9.

Spreadability of F1 to F9 formulations showed in figure 5, 6, and 7. F9 Gel formulations showed maximum spreadability than other gel formulations. Values of spreadability(mm) showed in table 9

Swelling index of F7 gel formulation was found to be 142% followed by F8 (121%), F4 (116%), F5 (105%) and F9 (91%). Maximum swelling index indicates matrix formulation which is useful in control drug release from gel formulations. swelling index of F1 to F9 formulations was showed in table 9

Microscopy of gel formulations for F1 to F3, F4 to F6 and F6 to F9 showed in figure

8, figure 9 and figure 10 respectively. Microscopy of F1 to F9 gel formulations were carried out. And it was observed that F2,F5,F6,F9 showed good clarity as compared to F1, F3, F4, F7, F8 gel formulations. It may attribute to the lower % of carbopol 940 increase clarity of gel formulations.

*In vitro* diffusion study carried out in diffusion cell for 24 hr showed F9 formulation with maximum drug release (96.11 %) as compared to the other gel formulations. As F2, F3, F9 showed maximum release as compare to the F1, F4, F5, F6, F7, F8 it may attribute to the % of carbopol 940 contribute to the drug release of gel formulation as decrease in % of carbopol 940 there is increase in % drug release. *In vitro* diffusion study shown in table 8, comparision of diffusion for F1 to F3, F4 to F6, F7 to F9 formulation has shown in figure 11, 12, 13 respectively.

As compared to the marketed formulation (Rextop gel) F9 formulation showed good results in % drug content, and drug diffusion study. It may attribute to low percentrage of carbopol 940(1%) and and propylene glycol (1%) is contributing to

drug content and drug diffusion. Drug content of F9 formulation was 97.33% and its % drug drug release was 96.11 which were better than other formulation. So F9 batch was selected as optimised batch. Comparision of *Ricinus communis* gel has shown in Table 9.

## 6. Conclusion

Natural remedies are more acceptable in the belief that they are safer with fewer side effects than the synthetic ones. Herbal formulations have growing demand in the world market. It is a very good attempt to establish the herbal gel containing hydro-alcoholic extract of *Ricinus communis*. This study revealed that the developed herbal gel formulation F9 was comparatively better than other formulation.

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